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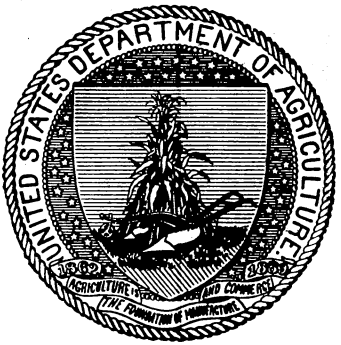
FARMERS' BULLETIN 365.

FARM MANAGEMENT IN NORTHERN POTATO-GROWING SECTIONS.

BY

LAWRENCE G. DODGE,

Scientific Assistant, Office of Farm Management, Bureau of Plant Industry.



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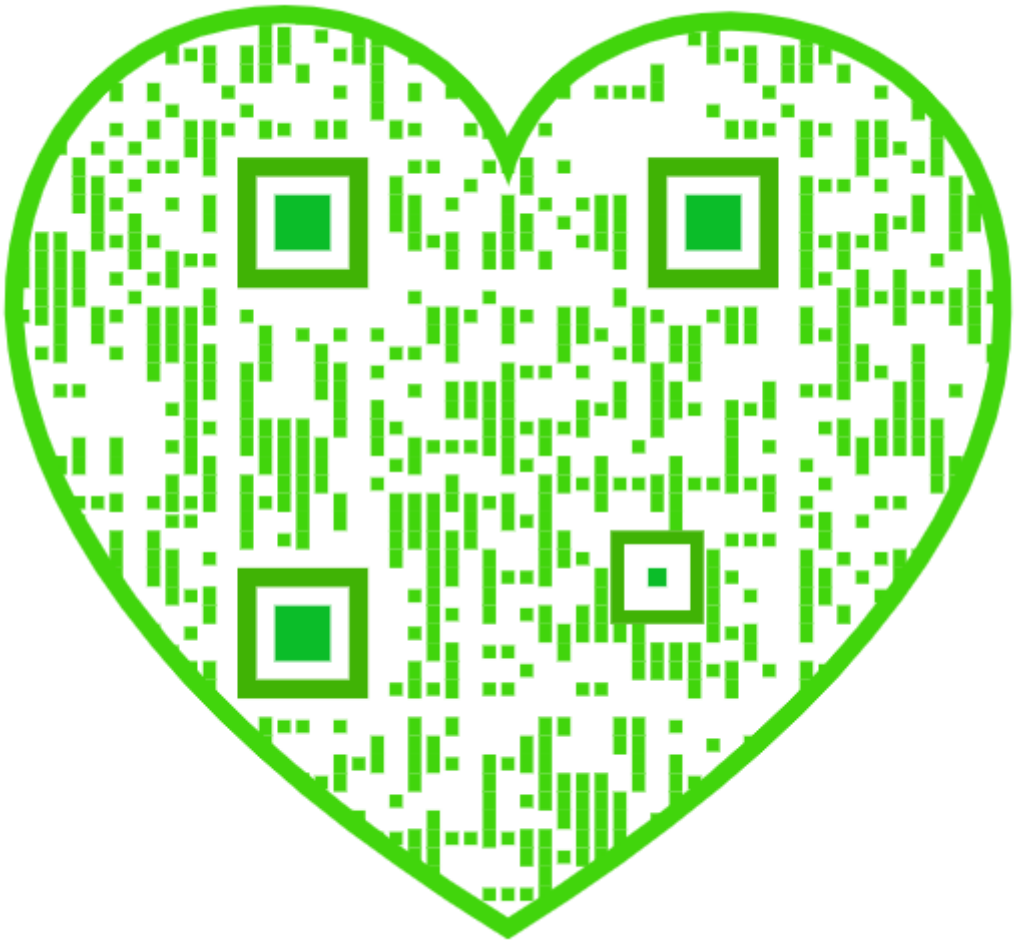

LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Bureau of Plant Industry,
Office of the Chief,
Washington, D. C., May 6, 1909.

Sir: I have the honor to transmit herewith a manuscript entitled "Farm Management in Northern Potato-Growing Sections," prepared by Mr. Lawrence G. Dodge, of the Office of Farm Management of this Bureau, and to recommend its publication as a Farmers' Bulletin.

This manuscript deals with the potato crop as a part of a system of farming, and gives special attention to the system of farming prevailing in Aroostook County, Maine, where potato growing is perhaps more highly developed than in any other section of the United States.

It is hoped to publish later bulletins giving specific instructions for the growing of potatoes in various sections of the United States.

Respectfully,

B. T. Galloway,
Chief of Bureau.

Hon. James Wilson,
Secretary of Agriculture.

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FARM MANAGEMENT IN NORTHERN POTATO-GROWING SECTIONS.

INTRODUCTION.

The white potato, often known as the Irish potato, is grown to some extent in every State in the Union. It plays an important part in farming, however, in the Northern States only, and throughout the North when the word "potato" is used it refers to the white potato. The leading potato-growing States of the country, those where the crop is at home and where it forms an important farm

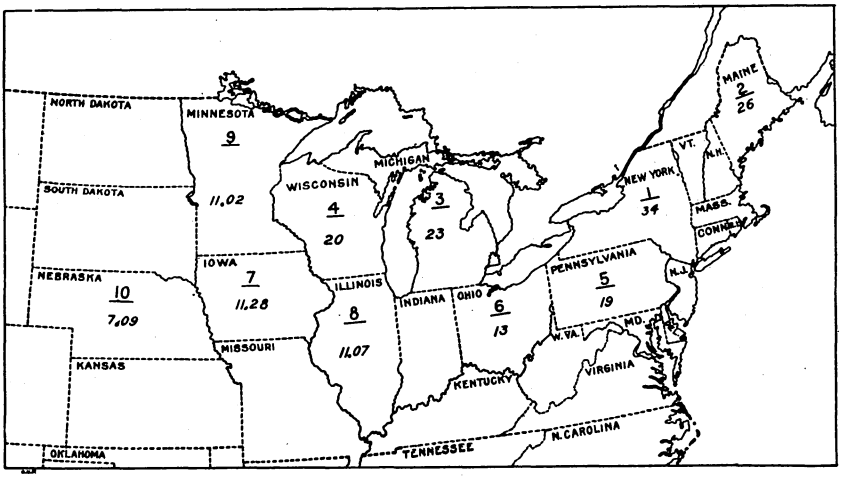

FIG. 1.—Map of the northeastern portion of the United States, showing (the order of production being underlined) the ten leading potato-growing States and their production of potatoes in million bushels in 1908.

crop, are the two northern tiers of States east of the one hundredth meridian. (See fig. 1.) Besides this region there are several States growing large quantities of potatoes, but not at all comparable with the district mentioned.

There are several States along the Atlantic and Gulf coasts where potatoes are an important crop, but in those States they must be

reckoned as truck crops in the majority of cases rather than as a general farm crop. In the Western States the white potato figures largely as an irrigated crop, but on account of the restricted localities where irrigation is possible here again the potato crop must be reckoned as a specialized industry.

It is not the intention in this bulletin to treat of specialized potato growing such as occurs on truck farms or in irrigated sections further than to refer to it in its relation to the crop as grown in the ten leading States.

STATISTICS OF POTATO GROWING IN THE UNITED STATES.

The production of potatoes in the ten leading potato-growing States in 1908, together with their total acreage and average yields per acre, is presented in the following table:

TABLE I.—*Production of potatoes in each of the ten leading potato-growing States of the United States in 1908, with total area planted and average yield to the acre for the year specified and for ten years, compared with the same statistics of production for the United States as a whole.*

State.	Area planted in 1908.	Average yield to the acre in 1908.	Average yield to the acre for ten years.	Total production in 1908.
	Acres.	*Bushels.*	*Bushels.*	*Bushels.*
New York	425,000	82	85	34,850,000
Maine	116,000	225	177	26,100,000
Michigan	325,000	72	84	23,400,000
Wisconsin	252,000	80	91	20,160,000
Pennsylvania	277,000	72	83	19,944,000
Ohio	170,000	77	81	13,090,000
Iowa	141,000	80	83	11,280,000
Illinois	156,000	71	85	11,076,000
Minnesota	145,000	76	86	11,020,000
Nebraska	91,000	78	84	7,098,000
Total in ten States	2,098,000	84.8	89.2	178,018,000
Total in all the States and Territories of the United States	3,257,000	85.7	90	278,985,000

A glance at this table shows that the average yield in Maine, 225 bushels per acre, is considerably more than for any of the other nine States, while no other State of the ten here listed shows an average yield for 1908 of more than 82 bushels. These conditions are not peculiar to the extreme season of 1908; the average yield for the past ten years shows that the production per acre in Maine is nearly twice that of any of the other nine States enumerated, though there does not seem to be sufficient difference in the climatic or other natural conditions to account for this wide variation.

IMPORTANCE OF THE POTATO CROP IN THE NORTHERN STATES.

The potato crop holds the most important place in the general farming of the Northern States as a whole in point of cash returns

to the acre. The potato not only thrives best in the cool climate of these States, but at the same time is very productive where the climate almost forbids corn growing. Consequently, in those Northern States where live-stock farming predominates the potato is likely to be the one crop grown to sell, all the other crops being fed to stock.

In many localities in these Northern States the potatoes are all consumed near the place of production, but through those States as a whole the crop is grown in such quantities as to be shipped extensively to other parts of the country. They are not only sent by the carload and boatload into the large cities both at the North and South, but from these States is shipped the supply of seed stock required by those sections of the South where early potatoes are grown as a truck crop. Some of those southern localities demand new seed from the North every year, and all of them are compelled to renew their seed at frequent intervals. On the Gulf coast, for instance, seed grown in the North the previous season will usually produce a crop from one to two weeks earlier than seed which has been grown in the South even for one year.

METHODS EMPLOYED IN GROWING POTATOES IN AROOSTOOK COUNTY, MAINE.

YIELD.

In view of the various yields of potatoes in the different States it seems worth while to inquire into the reasons for the high standard of potato culture in Maine. The largest potato-growing county in the United States is Aroostook, in the northernmost part of Maine, and in fact the northernmost part of the United States east of the Great Lakes. While potatoes are grown to some extent over the southern and western parts of Maine, the great bulk of the crop for the State is produced in this one county, probably 18,000,000 or 20,000,000 bushels out of the 1908 crop being grown there. From careful observation of the growing of the potato crop in Aroostook County it appears that the yield there averages about 275 bushels (100 barrels) per acre.

MARKETS.

Aroostook County has no special market advantages for disposing of its crop, but, on the contrary, is some 350 miles or more by rail from Boston and more than 100 miles from tidewater. From Houlton, which is at the nearer or southern end of the section, freight to New York by rail amounts to 42 cents a barrel (165 pounds), and as potatoes are frequently put up in barrel sacks costing 10 cents apiece,

the expense for each barrel amounts to 52 cents. From other towns farther north the freight is still more. The greater part of the year is required to ship all the potatoes out of that locality, shipping usually commencing the latter part of August and lasting until late in June.

CLIMATE, SOIL, ETC.

The climate of Aroostook County is cold, with a short growing season, the effect of which is probably felt more in hindering the successful production of other crops than in the advantage to the potato crop. The soil is in general a friable loam containing a good many loose, small stones, and though the general character of the soil is said to be quite similar over the surrounding territory, potato growing is mainly confined at present to a strip of country some 25 miles wide and perhaps 100 miles long near the New Brunswick border, the remaining portion of similar land still being a lumbering section. The upland, which was formerly covered with beech and maple forest, is the most suitable for potato growing, for it is naturally well drained. The rainfall is heavy and the drier seasons are the most prosperous ones for the potato growers.

ROTATION OF CROPS.

The general methods of potato culture in use have developed during the past fifteen years, or a little more, and are followed with considerable uniformity throughout the section. The rotation is a simple one, but is undoubtedly the foundation of the success of the growers. Potatoes are grown on any piece of land only one year as a rule and are followed by one crop of oats or spring wheat, with which are sown clover and timothy for hay. This crop is cut for hay one year by many of the best farmers and plowed in the fall for a new potato crop. The furrow is usually turned to a depth of 7 or 8 inches, and on most of the farms this work is done with a reversible sulky plow, an implement admirably adapted to working on sidehills. Some growers like their hay fields to stand a second year before plowing, but rarely longer than that, for the land is in too much demand for potatoes to continue it in grass more than two years.

The sod, usually containing a large amount of clover which was plowed the previous fall, is harrowed in the spring as soon as the season permits, usually being worked over thoroughly four times in all with a disk harrow followed by a spring-tooth harrow.

PLANTING.

Planting is done from the 15th or 20th of May to the 1st of June, using about 5 barrels of seed to the acre; that is, 13 or 14 bushels. The seed is cut by hand into pieces containing about two eyes and of

such a size as to feed readily through a planter, and is dropped by the planter in rows about 33 inches apart and from 12 to 15 inches

FIG. 2.—Potato planter of the picker type.

apart in the row, so that the ground is entirely occupied with the crop and the vines in midseason meet in the rows.

FIG. 3.—Potato planter of the type operated by two men.

There are two prevailing types of planter, in one of which the seed pieces are distributed by steel forks or pickers and in the other by

pockets in a revolving disk. Both types are two-horse machines, the former being operated by one man and the latter requiring a second man to attend to the seed distribution, but insuring a more perfect stand. Either type will plant about 5 acres per day. (See figs. 2 and 3.) The planter at the same time distributes the fertilizer, from 1,200 to 1,500 pounds per acre usually being applied. This amount of fertilizer can be safely used directly in the drills. The fertilizer commonly used contains about 3 per cent of nitrogen, 7 or 8 per cent of phosphoric acid, and 9 or 10 per cent of potash.

CULTIVATION.

About the time that planting is finished the larger grower usually commences cultivation on the first-planted portions of the field. A horse hoe is most frequently used the first time, following the row either by the plants which are just appearing or by the slight ridges

FIG. 4.—Horse hoe and hilling attachment on a sulky cultivator used at Caribou, Me.

left by the planter. The rows are hilled up sufficiently to cover any potato plants which may have appeared. This is usually followed by a cultivator, some type of the two-horse riding cultivator being most commonly used. This operation commences about a week or ten days after the beginning of the first working, often as soon as the whole crop can be worked over once with the horse hoe. This treatment is usually kept up with the cultivator and horse hoe, alternating until the vines nearly cover the ground, at some time in July, usually calling for six or seven cultivations, ending with the horse hoe or some appliance to take its place in ridging up the rows. (See fig. 4.) This turning of the loose soil upon the potato row has proved most effective in checking the growth of weeds in the row, and is usually

relied upon to accomplish that result, since hand hoeing is out of the question when one farmer has 50 or 75 acres of potatoes, as frequently is the case.

SPRAYING.

Usually before the cultivating is finished, spraying the crop has commenced. Bordeaux mixture for the prevention of blight, with Paris green or some other arsenical preparation added to kill the potato beetles, is applied from a sprayer cart drawn by either one or two horses, with power applied from the wheels for driving the pump. (See fig. 5.)

Copper sulphate or blue vitriol and quicklime are used at the rate of 6 pounds of each to 50 gallons of water. The lime is best slacked in one tank or barrel, the blue vitriol dissolved in another, and each

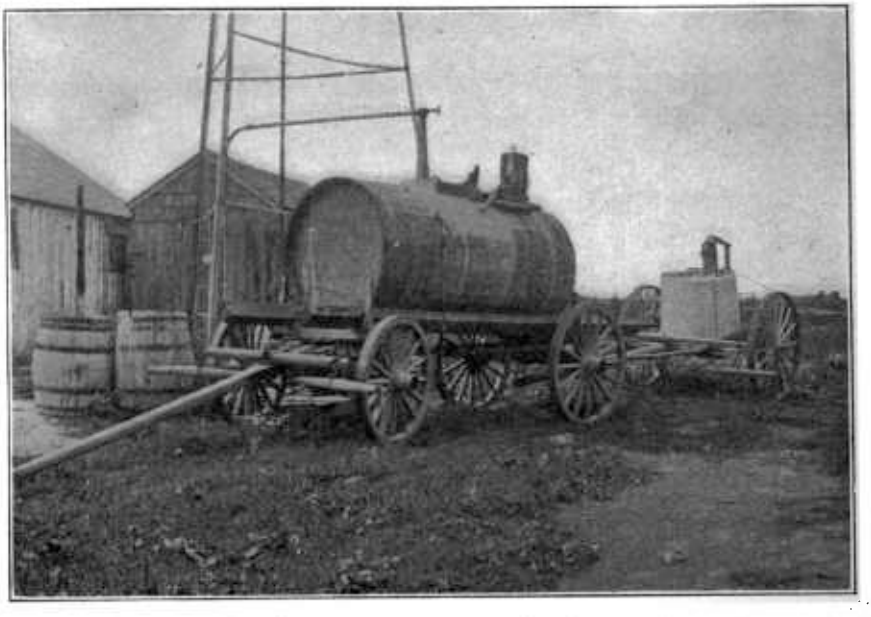

FIG. 5.—Tank for hauling spraying mixture to the field, with a two-horse sprayer in the rear.

is usually diluted until the whole quantity of water is used before they are mixed. These proportions are safe only when the lime is new and of full strength, and when there is any doubt about the strength of the lime a safer proportion is 5 pounds of blue vitriol to 6 pounds of lime. About 50 gallons of the solution are applied to the acre, and at the first spraying of the season a pound of Paris green for each acre is added to the Bordeaux mixture. Once, later in the season, Paris green is applied in the same way to kill the second brood of beetles. The use of Paris green in this way has proved very effective, so much so that the beetles are much less troublesome than

they were a few years ago. In the opinion of some of the leading potato growers the principal requisite in applying Bordeaux mixture is to have on the spraying apparatus a pump of sufficient capacity to produce a very fine, mistlike spray which will drift all through the mass of growing vines in the row and settle upon all parts of the foliage. Spraying is done from three to five times during the growing season, and is considered an absolute necessity for a successful crop, so that very few potato growers in Aroostook County think of doing without spraying their crops for prevention of blight.

DIGGING.

The Green Mountain is the principal variety of potato grown in Aroostook County, but the Irish Cobbler and one or two less im-

FIG. 6.—Digging potatoes near Caribou, Me., showing the heavy elevator digger and the low-down wagon used.

portant early varieties are grown to some extent. Some of the earlier ones are ready to dig about August 20 or 25.

Digging usually is carried on with only short interruptions from about the 20th of August until the middle of October, when it is usually necessary to have all the crop dug and stored on account of freezing weather. The great bulk of the crop is dug between September 20 and October 10.

The crop is dug entirely by machine, one of the large, heavy elevator diggers being found necessary. (See fig. 6.) This work requires either two or four horses, according to the condition of the land. The digger will usually turn out about 3 acres a day, and

from seven to nine pickers are required to keep up with it. This is about the only hand labor required, since the crop is worked entirely by machine from the time the seed is ready for the planter until the potatoes are turned out of the ground and lie ready for picking up. Not only is hand work limited to these two operations, but for the major part of the machine work the man is not required to walk. This plan of operations involves considerable expenditure for machinery, but enormously increases the efficiency of one man.

USE OF MACHINERY.

Mr. J. M. Ward, of Limestone, Me., enumerates the necessary machinery for potato growing as follows:

2 sulky plows	$100
2 spring-tooth harrows	25
1 planter	65
1 2-row riding cultivator	45
1 horse hoe for hilling	10
1 4-row sprayer	65
1 digger	100
Total	410

This equipment, with the addition of one wagon of the type known as a jigger (see fig. 6), is operated by two men and four heavy horses. The two men with this equipment are able to prepare for, plant, and handle 50 acres of potatoes up to digging time, when they require six or seven day hands to pick up the potatoes. This, of course, is an expensive equipment compared with that formerly used on the potato crop, which was as follows:

1 walking plow	$15
1 harrow	15
1 horse hoe	10
Hand hoes	3
Total	43

Without question the additional outlay increases the acreage which two men can handle just about in proportion to the increase in cost.

STORAGE.

Most of the farmers have potato houses or cellars constructed for storing their stock and holding the unsold portion of the crop through even the coldest weather until they can market it. Some growers, especially those near town, depend on the warehouses of the dealers alongside the railroad tracks. The common type of storehouse on the farm is a cellar walled up with concrete or stonework, about 8 or 9 feet deep, with a low wooden roof above it, giving a considerable space for the storage of tools, barrels, etc., on the floor above

the cellar portion. (See fig. 7.) These cellars are usually built on the side of a hill, so that the potatoes are unloaded down through the floor in the fall and taken out at a lower doorway during the winter.

PROFITS.

The crop has been averaging for the past few years a price of $1 per barrel, or a little better, to the farmer at the shipping station, and at that rate proves a very profitable crop, for it is estimated to cost from $50 to $60 an acre to grow 100 barrels, counting in the cost of labor, seed, fertilizer, and rent of land. Although this would indicate a profit of from $40 to $50 per acre, or perhaps a little more, it must be remembered that this crop is produced not oftener than every third year on a given piece of land, and in the interim the grain crop and hay crop will pay no such profits, although the yields of both are good and their production is well worth while. On many potato farms of Aroostook County much of the hay and grain is sold, usually to the logging camps in the lumbering country quite close at hand.

FIG. 7.—Potato storage cellar at Limestone, Me.

IMPORTANCE OF CLOVER IN THE ROTATION.

One frequently finds large farms of 200 or 300 acres, having perhaps 200 acres of tillable land, on which are kept only sufficient horses for handling the crops and one or two cows for the home supply of milk and butter. With so few live stock from which manure may be obtained, it is reasonable to conclude that the rotation involving a crop of clover on which to grow the potato crop is an essential. On some of the older farms, where oats and hay had been grown for a long term of years, the present system has done much in the last twelve or fifteen years to improve the condition of the land. It is often claimed that under the present system, even without barnyard manure, the land is gradually improving. So long as the clover crop is a success on these farms the system bids fair to prosper. If for any cause, however, the clover crop should cease to be successful, the prospects of this system of farming would be seriously injured.

When land located near a town is renting at from $14 to $16 an acre for one year for the purpose of growing a crop of potatoes, men who hire such land are often willing to pay $2 an acre more if the land has a good clover sod on which to plant their crop than if it has merely an old grass sod.

CAREFUL CULTIVATION THE KEYNOTE OF SUCCESS.

As further evidence that successful potato culture, even in Aroostook County, is largely due to the treatment of the crop, some experience with individual fields may be quoted.

Of a number of acres of potatoes grown at Houlton, Me., one season recently, a part of the field was harrowed twice with a spring-tooth harrow; the rest of it was harrowed thoroughly four times, twice with a disk and twice with a spring-tooth harrow. In all other respects the two portions of the field were treated alike. The crop on the portion which received the less harrowing averaged 80 barrels per acre and that on the thoroughly harrowed part 100 barrels per acre.

Again, on a small field of 3½ acres in the northern part of Aroostook County the crop was cultivated fourteen times during the season of 1904. The land had previously been handled for several years in an excellent manner as regards rotation and tillage. In an adjoining field on very similar land another farmer raised 6½ acres which received two cultivations for the season, once with a cultivator and once with a horse hoe. The latter field had received less careful management in previous years. In other respects the two lots differed little in treatment. The yield on the first was 140 barrels per acre, or 490 barrels on 3½ acres. The yield on the second was 70¾ barrels per acre, or 460 barrels on 6½ acres—30 barrels less in all than on the smaller lot.

The thorough and frequent working of the land for the potato crop has accomplished another result. When the present system of potato culture was commenced in northern Maine, witch-grass, or quack-grass, threatened the success of the business most seriously. At the present time this weed is one of the least serious difficulties to be overcome. Thorough working of the land occupied with a potato crop is part of the solution for this problem. This includes especially the work of the potato digger, for it shakes loose from the row any witch-grass roots which may have escaped the cultivation of the early season. A short rotation is another factor tending to the extermination of witch-grass by giving little opportunity for it to occupy the land.

METHODS EMPLOYED IN GROWING POTATOES IN OTHER SECTIONS.

As an indication that the success of these potato growers is not by any means largely due to their local conditions, it is well to note the success of potato growing according to similar methods in other localities.

POTATO GROWING IN CENTRAL AND SOUTHERN MAINE.

In central and southern Maine, where the land has been considered unsuited to potato growing and is valued at from $25 to $40 an acre, in contrast with the $80 and $100 land of Aroostook County, the same methods have been applied with equal success. One often hears of Aroostook County farmers who have sold their expensive land in the northern part of the State and are buying cheaper farms in the southern counties.

On the farm of W. J. Thompson, in Kennebec County, Me., 10 acres of potatoes were grown according to the Aroostook system in 1907, that method being followed throughout in culture, in the application of fertilizer, and in spraying. All the labor of men and teams was hired at current prices. The total cost of 10 acres for labor, seed, fertilizer, and spraying materials, including the hauling of the potatoes to market, was $754, of which $144 was for transportation to market. The land used was old, run-out fields and pasture, and no barnyard manure was applied. There was a yield from 10 acres of 1,800 bushels of market potatoes, which sold at 72 cents, bringing $1,296, a profit of $542 on the 10 acres. This farm was located some 200 miles nearer the large markets than is Aroostook County, and accordingly the better price for the crop made up for the lighter yield. To raise 18 acres of oats, following the potatoes of the previous year, cost $216 for labor and seed, but with no additional fertilizer. The oats yielded 40½ bushels per acre, or 730 bushels in all, which sold at the farm for 60 cents a bushel, amounting to $438, and 13 tons of straw, valued at $4 a ton, giving a profit on the 18 acres of $274, or of $222 on the grain alone. A good stand of clover was also obtained that year and the previous year, the clover-mixed hay yielding at least 1½ tons per acre in 1907, having been seeded with oats the year before. These figures would indicate that on a good clover sod, such as is now becoming available on this farm, as large yields of potatoes can be obtained as are common in Aroostook County.

POTATO GROWING ON LONG ISLAND.

Some variations of the Aroostook plan are employed in numerous other places. On Long Island, for instance, in the truck-growing

section very similar methods are employed. The one different feature worth noting seems to be that level cultivation is the general rule on Long Island. Aside from this, the milder climate of Long Island allows the use of crimson clover. Although that crop is not hardy enough to survive the average Long Island winter, the experience of one farmer there has shown that when sown in August, following rye, it will make sufficient growth before winter to be worth while plowing under the following spring for potatoes, and this allows a crop of potatoes every other year and a crop of winter rye, usually profitable for the straw, in the intermediate year. The level cultivation on Long Island is due mainly to the difference in the supply of available moisture. In northern Maine the method of hilling previously described is frequently necessary to keep superfluous surface water away from the potato plants. On Long Island level culture is utilized to help retain the available supply of moisture in that region of more sandy soil and less abundant rainfall. There, instead of using the horse hoe to any extent, the early cultivation of the potato crop is done almost wholly with the weeder, this implement being used sometimes three times, or continuously until the plants are 5 or 6 inches high. From that time on the crop is worked with a cultivator, and any attempt to hill up the rows is avoided.

Spraying with Bordeaux mixture is practiced in the same manner as in Aroostook County. In addition many potato growers on Long Island are using the formaldehyde treatment on their seed potatoes to reduce the damage from scab. This disinfection is usually accomplished by soaking the seed potatoes for an hour and a half in a solution of 1 pint of formaldehyde to 30 gallons of water. The soaking is done before the seed is cut and then the seed is spread out to dry. In this way the fungus which causes most of the scabby potatoes, in the East at least, is destroyed so far as the tubers are concerned, and the seed potatoes are considered to be one of the chief means of spreading this disease. To do this work more rapidly where large quantities of seed are to be treated the seed may be spread on racks and fumigated with formaldehyde gas. For this purpose the racks should be arranged as compactly as possible in a room which may be tightly closed so as to prevent the escape of any of the gas. When the potatoes are all in the racks, 23 ounces of potassium permanganate for each 1,000 cubic feet of space in the room should be spread thinly in shallow pans, and over this 3 pints of formaldehyde should be poured. The room should be closed at once and allowed to remain closed for twenty-four hours.[a]

[a] For a more detailed account of this method of treatment, see Circular No. 23 of the Bureau of Plant Industry or Bulletins Nos. 141 and 149 of the Maine Agricultural Experiment Station.

POTATO GROWING IN WESTERN NEW YORK.

Potato-growing methods similar to those described in Aroostook County are employed by numerous planters in western New York on rather heavy soils containing gravel or clay loam, and even where considerable underdraining has proved necessary. Mr. T. E. Martin, of Monroe County, N. Y., has raised 18 acres of potatoes each year on such a heavy soil, all of which it was necessary to underdrain. With a three-year rotation of wheat, clover, and potatoes, fertilized with 1,600 pounds of home-mixed fertilizer, he has grown an average of more than 300 bushels to the acre, and in 1906 raised an average of 417 bushels on the 18 acres. He employs thorough cultivation and thorough spraying with Bordeaux mixture.

Another potato grower in western New York, Mr. J. D. Taylor, of Steuben County, has had repeated success in growing potatoes without commercial fertilizer, using a three-year rotation and stable manure. He gets one crop of hay in the year following the wheat crop, and soon after mowing spreads 20 loads of light, strawy manure per acre on the stubble. He lets the second crop grow up through this and fall down. The whole is then plowed under late in March or early in April and planted to potatoes a month later after thorough preparation. No commercial fertilizer is applied, and with the variety of potato known as Sir Walter Raleigh the usual yield is from 250 to 300 bushels to the acre.

In general it has been found exceedingly profitable in any part of the State of New York to spray potatoes with Bordeaux mixture as a preventive of blight. A series of experiments carried on by the Geneva Agricultural Experiment Station in cooperation with numerous farmers scattered over the State showed an average gain of 50⅓ bushels to the acre for spraying. The average net profit from a series of five years of business experiments carried on by the Geneva station in cooperation with numerous farmers was $19.86 per acre. The average gain in yield for six years in experiments with spraying every two weeks carried on at the Geneva station was 121⅔ bushels. A similar series of experiments carried on by the substation on Long Island under drier climatic conditions showed an average gain of 60½ bushels. This seems to be conclusive proof that the use of Bordeaux spray in preventing loss from blight is a thoroughly profitable proposition in a climate either like that of central New York or of Long Island, where less rain prevails.

POTATO GROWING IN MICHIGAN AND WISCONSIN.

In Michigan the prevailing practice is to use commercial fertilizers sparingly or not at all. The seed is usually planted farther apart, often being check-rowed 34 or 36 inches apart each way, and the

work throughout the season is usually done on a less expensive scale than in Maine. There are, however, numerous farmers who get yields much heavier than the 150 bushels, more or less, so commonly grown by the cheaper methods.

One grower who keeps considerable live stock, both cattle and sheep, always plants potatoes on a clover sod which has been pastured by sheep one season after being seeded with grain the previous year. This sod receives a light application of sheep manure during winter after the grain is cut, or perhaps during the summer when it is being pastured. Without commercial fertilizer, with the crop check-rowed 34 inches each way and thoroughly cultivated in both directions, and with the best of seed, more than 200 bushels to the acre are obtained.

A grower in central Wisconsin who keeps a considerable flock of sheep and plants seed taken from the best-yielding portions of his field only has maintained a yield of about 200 bushels an acre, a point which his neighbors who have less live stock and plant cull potatoes have been unable to attain. According to some of the most successful potato growers in Wisconsin the land there is falling off in its potato production even when clover sod is available, but wherever live-stock raising is being introduced and a supply of barnyard manure becomes available the crop is much larger. An application of 15 loads of barnyard manure per acre, each load weighing a ton to a ton and a half, has been shown to approximately double the potato crop, and when carefully applied—that is, not immediately before potato planting—has shown no bad results in causing scabby potatoes. In central Wisconsin dairy cattle and the use of silos seem to be increasing, and as this type of farming comes in, involving a more rapid crop rotation upon the land and the return of humus to the soil by means of barnyard manure at the same time, the potato yields promise to increase steadily.

Commercial fertilizers are still more in general distrust by the majority of potato growers in Wisconsin than by those in Michigan, but it is very probable that a judicious use of commercial fertilizer containing a high percentage of potash could be profitably employed by these men in connection with available manures and clover sod.

Spraying with Bordeaux mixture for blight is generally considered unnecessary in Michigan and Wisconsin, but the experience of growers who have used this mixture indicates that its use would result in sufficient gain in yield when the blight is severe to pay a handsome profit on the cost of spraying every year. For instance, in Van Buren County, Mich., on the farm of Mr. Jason Woodman, the portion of

the potato crop in 1907 which was carefully sprayed with Bordeaux mixture produced a yield of 263 bushels per acre, and the unsprayed rows at the rate of 168 bushels per acre. Where horse spraying outfits are employed to apply Paris green to the potato crop it would be very little added expense to use Bordeaux mixture at the same time and so protect the crop from blight.

VARIOUS MEANS EMPLOYED IN HANDLING THE CROP.

In other sections of the potato-growing States different means are employed with certain parts of the handling of the crop. On some of the sandy loam soils fairly satisfactory work is done in digging by the use of a simple plow digger, such as is shown in figure 8. In some of the more western localities the crop is sorted in the field with the aid of a screen which is dragged along the field. (See fig. 9.) In those same sections a rough dugout takes the place of more expensive cellars. In some parts of Michigan and Wisconsin the crop is stored in pits in the field until it can be marketed, but has to be shipped or taken to some permanent storage before winter sets in. These pits are made by merely digging off the surface soil to the depth of a foot or a little more, then piling in the potatoes to perhaps 3 feet above the surface of the ground. After that they are covered with a layer of straw, and then with the loose soil that was dug off at first. (See fig. 10.)

FIG. 8.—Potato digger of one of the simplest types.

COST OF PRODUCING POTATOES.

The following table represents the usual expense of growing an acre of potatoes in Aroostook County, Me., and in many parts of Michigan and Wisconsin. In fact, the second column of figures will

represent the expense put into growing the crop in most localities where potato growing is carried on on a less expensive and thoroughgoing basis.

TABLE II.—*Cost of producing 1 acre of potatoes in Maine and in Wisconsin.*

Cost of supplies and labor, with rent of land.	Maine.	Wisconsin.	Cost of supplies and labor, with rent of land.	Maine.	Wisconsin.
Plowing	$1.50	$1.25	Cultivating	$3.50	$1.90
Harrowing	.50	.25	Spraying	3.00	a.80
Fertilizer	24.00		Digging	6.00	2.10
Seed	5.00	2.50	Rent of land	15.00	5.00
Cutting	.75	.60			
Planting	.75	.60	Total	60.00	15.00

a For beetles only.

The more expensive method of growing potatoes usually gives a yield of 275 bushels or more to the acre. Unless an application of barnyard manure is made in addition to the expense estimated, at an added cost of from $5 to to $10 per acre, the less expensive method rarely produces more than 125 bushels per acre and in a great many instances decidedly less than 100 bushels per acre. The increase in yield as a result of the more costly method is sufficient to more than pay the difference in cost, supposing potatoes to sell as low as 33⅓ cents a bushel. One hundred and twenty-five bushels per acre grown at a cost of $15 per acre and sold at 33⅓ cents per bushel yield a net profit of $26.66 per acre. Two hundrd and seventy-five bushels per acre grown at a cost of $60 per acre and sold at 33⅓ cents per bushel yield a net profit of $31.66 per acre. The second profit is $5 more per acre than the first.

FIG. 9.—Sorting potatoes in the field over a portable screen.

A farmer in Van Buren County, Mich., states that his potato crop, mostly marketed in the fall, sold at an average price of 44 cents a bushel for a period of ten years. At the latter price the more expensive method of culture would yield a profit of $61 per acre, against $40 from the cheaper method. Furthermore, some of the leading

potato dealers of the North have stated emphatically that a better quality of potatoes is normally obtained with large yields than with small.

PROBLEMS CONFRONTING AROOSTOOK COUNTY GROWERS.

Although the present system of potato growing in Aroostook County is proving fairly profitable to the growers, one is forced to ask how long this condition will exist before the clover crop becomes less dependable. This question arises when one considers the results that have come to other sections where a similar system of farming, involving little or no live stock, has been followed. When mixed

FIG. 10.—Pit used for storing potatoes in the field, near Greenville, Mich.

clover hay is sold to the logging camps at $8 or $9 a ton, as has frequently been the case in Aroostook, it is questionable how much profit is to be had by curing the hay crop and selling it at such prices. At the usual price for commercial fertilizers a ton of clover hay contains something like $9 worth of nitrogen, phosphoric acid, and potash. Accordingly, a few of the most successful potato growers do not try to make hay when it will interfere with giving proper care to tilling or spraying their potato crop. They have found it more profitable to spend all the time necessary in caring for the potato crop and then to cut and cure only so much hay as time will allow. Then if time is not sufficient for curing their whole hay crop some

of the fields are mowed and the grass allowed to lie on the ground until time to turn the sod under for the next year's potato crop.

In the particularly rainy season of 1907, when the crop fell way below the average in Aroostook County, Mr. D. D. Powers followed such a plan as this and let a large number of acres of hay go to waste so far as the hay was concerned. Mr. Powers, however, harvested a crop of potatoes which was about 90 per cent of a normal yield, while several of his neighbors who neglected the care of their potatoes during the summer in order to cut their hay harvested that fall only about 70 per cent of a crop of potatoes. Mr. Powers felt that he was well repaid the same season for following this method and that his potato crop the next year would also be considerably better on the lots where the hay was turned under.

MAINTENANCE OF SOIL FERTILITY.

It has been frequently predicted by many persons who have studied the situation that some day the clover crop in Aroostook County will be less successful than it now is. If such a time comes potato growers will very soon begin to suffer for want of more live stock in their system of farming. Although the use of an amount of potash in the fertilizer applied to an acre of potatoes which is twice that actually contained in 100 barrels of the crop probably is of great benefit to the ensuing clover crop, it is impossible to determine how long that supply of potash unaided will insure a good stand of clover. In several different places in the United States it has happened that under such a system of farming without live stock the clover crop in the course of time began to fail and in a few years after the clover crop failed everything else followed it. There is such a section in the southern part of the State of New York where clover, potatoes, and small grains were grown successfully until some twenty years ago. At that time for want of live stock as a source of manure the clover began to fail, and for the last fifteen years there has been no successful clover raising in that section and very few profitable crops of grain or potatoes. Farmers in that section, to be sure, were not using fertilizers to any such extent as are the Aroostook County potato growers, but it does not seem safe to prophesy that even with large amounts of commercial fertilizer the clover crop of Aroostook County can be made a success for an indefinite number of years to come. The extension of the dairy industry, which has such a wide development in other parts of Maine, has been predicted for this county. Dairying may come in to some extent and supply the needs for farm manures, but there are frequent and emphatic objections raised when such a statement is made. Some of the most successful potato

growers say that they and their farm laborers are both unaccustomed to the care and handling of dairy cattle and that at certain seasons of the year the time required to care for dairy stock would seriously interfere with the work of potato growing. This objection is very reasonable on farms where the potato business is developed on a large scale, where the acreage grown every year is high, perhaps 50 to 100 acres, and where the owners are not familiar with the methods used in handling cattle.

Pasture land as a rule is of such limited extent as to make sheep raising impracticable. Most potato growers have only a small proportion of the pasture necessary for the number of sheep for which they would have hay. The potato growers of Weld County, Colo., overcome this difficulty by buying range sheep and feeding them for the winter in a small corral. In that way the alfalfa hay grown there in connection with the potato crop and holding the same relative position as clover hay in Aroostook County, Me., is not only consumed on the farm at a profit, but gives sufficient manure to be of great advantage to the farm. There are several farmers in the northern part of Aroostook County, however, whose systems of farming seem to offer another solution of this question. These men are keeping a few brood mares of Percheron blood and find them especially profitable. Heavy draft horses, those weighing 1,400 or 1,500 pounds, are used very extensively in the potato fields, and a good pair is often worth $700 or $800. A great many such horses are brought into the county every year and sold at good prices. The men who are raising these animals on a small scale find them the most profitable means of marketing their hay and grain crops, and as the supply of heavy farm horses is scant as a general thing in all the Eastern States the raising of draft horses promises to be one of the most profitable adjuncts to potato growing in Aroostook County. Raising horses of this type should not be confused with the raising of light-weight horses so often practiced by eastern farmers in trying to raise trotting horses. The ordinary farmer who attempts to raise a trotter is more likely to fail in that and then have a worthless animal so far as good thorough farm work is concerned.

APPLICATION OF BARNYARD MANURE.

Some potato growers say they do not wish to put stable manure on the land for their potato crop. There are two ways of obviating this objection. In every section of the potato-growing States there are numerous instances of the application of manure to the potato crop without injury to the quality of the crop. Generally, however, some precaution is taken in applying the manure. It is usually put on

the land during the previous summer if the land is to be fall-plowed, or at least applied in the fall or early winter to land which is to be plowed in the spring for potatoes. If bad results to the potato crop are to be feared from this procedure still further precautions may be taken by applying the manure as a top-dressing on new seeding after the grain is cut. The loose, strawy, rather dry horse manure, such as would be produced on a farm where draft horses are raised, would not ordinarily work well as a top-dressing. It would not decay sufficiently fast nor could it be distributed finely enough, but where lumber is so near at hand and relatively cheap, as in Aroostook County, the farmer will find no difficulty in building some sort of manure shed or small covered barnyard, such as is used in many places in New York and some of the Central States. Under a roof even strawy horse manure when trampled by the stock and allowed to settle and rot to some extent could then be spread successfully as a top-dressing. It would further retain much of its value as a source of nitrogen if treated at frequent intervals with light applications of gypsum, or land plaster.

PROTECTION FROM SCAB.

In the opinion of some of the best potato growers in Aroostook County the trouble which threatens them most seriously to-day is the injury of their crop by scab. Up to the present time very little thought has been given to the treatment of seed potatoes for scab, though great care has been exercised to avoid any treatment of the potato lands tending to encourage the growth of scab, such, for instance, as the application of wood ashes or barnyard manure. The treatment of the seed potatoes with formaldehyde, either in solution or as a gas, is likely to prove of great benefit to the quality of the potato crop in Aroostook County.

ROTATION WITH CLOVER FOR SEED.

A further aid in the improvement of this system of farming is suggested by the experience of the farmers in the potato-growing sections of northern Michigan and by an occasional farmer in Aroostook County. In some parts of Michigan a large part of the clover crop is harvested for seed, in some cases the chaff being fed to sheep or other stock and in others spread on the land. In Aroostook County there have been some excellent yields of clover seed and a handsome profit realized from the crop. Mr. J. W. Dudley has grown on his farm in that county a field of clover of 2½ acres which yielded 5 bushels per acre. The crop was cut August 25, and with clover seed selling at 16 cents a pound was worth $48 per acre. This crop is less expensive to harvest than hay and always involves less risk in

curing. Besides these advantages, when the clover crop is harvested for seed, although the seed is sold at a better price than could be realized from hay, all the rest of the crop is returned to the land either as manure or in the form of chaff. With the scarcity of clover seed which has prevailed in recent years and the accompanying high prices, this crop is decidedly one of the most profitable adjuncts to the potato-growing business, especially in those sections where, owing to the latitude, corn is an unsatisfactory crop or where for one reason or another sufficient live stock are not kept to utilize all the feed grown on the place.

SEED SELECTION.

The majority of farmers, even those who make a specialty of potato growing, acknowledge that they use for seed the tubers that are too small to sell, and some even tell boastfully how they have followed that plan for many years and are still raising the same variety. It is at the same time noticeable that a farmer does not often exhibit a variety of potato which he has grown consecutively for many years from seed produced on his own farm. Why should a variety of potatoes "run out" and be discarded after a period of years any more than a variety of corn or apples? The common practice of planting cull tubers very probably explains in part the deterioration of a variety in the Northern States, where the potato plant is in a favorable environment so far as natural conditions go. In contrast to the common practice, an occasional farmer is to be found who uses some care in the choice of seed stock. Some take all of the crop from that portion of the field which has the best stand and gives the best yield, both in quantity and quality. Others pick medium-sized tubers of the desired shape and general appearance from the bins after the crop is in storage. These men usually maintain the yield and quality of their potatoes somewhat above that of their neighbors.

SELECTION BY HILLS.

An occasional potato grower is heard of who gets ahead rather more rapidly by following more thorough methods. One man in Michigan started several years ago by saving a large number of separate hills of potatoes. Each hill was from one seed piece, and only such hills as contained six or more smooth tubers of merchantable size and no cull tubers were saved. Of the potatoes grown in the field the first year, only 16 hills out of every 100 were of the standard required. All the tubers from those hills were planted, and soon enough seed was available for the entire crop, the selection in subsequent years being made from the most thrifty-appearing

portion of the field. After the plan had been followed for five years 70 hills out of 100 were found which met the requirements, i. e., the percentage of good hills had been increased from 16 to 70 in five years of selection. The yields on this farm were about double those on the ordinary farm in the same locality, and all the increased yield could not be attributed to the better culture of the crop. The yielding power of the good hills of potatoes in this case was not necessarily increased at all, but the progeny of vigorous plants furnished more and more of the seed for the crop. The writer has had the opportunity to select some hills of Rural New Yorker potatoes for two years. The first year 8 per cent of the hills were saved, and of the crop grown from that 8 per cent the second year there were found to be 20 per cent which met the requirements. (See fig. 11.)

FIG. 11.—Individual hills of potatoes as they grew in the field, with good and poor hills close together.

Some of the State agricultural experiment stations have carried on the hill selection of potatoes for two or three consecutive years, far enough at least to show definitely that the increased yield of a variety comes most rapidly and unfailingly from the hill method already suggested, provided a hill grows from one piece of seed as the unit of selection. Even though no change is brought about in the character of the seed the percentage of unproductive seed is decreased by this means, and the standard of the whole approaches that of the few best hills in the beginning. (See fig. 11.)

No matter how good a tuber is it may come from a distinctly poor hill where it was the only good potato out of many, the rest being all of unsalable size. The tendency for a tuber to reproduce not the characteristics of itself alone, but those of the whole hill of which

it was a part, was indicated by the experiments referred to. For the reason, no doubt, that many of the small potatoes come from heavily yielding hills the seed derived by planting culls continuously runs out slowly. In short, even a small potato from a good hill of which it was the only small tuber is preferable to a large tuber from a poor hill where it grew with many small ones. As medium-sized potatoes are preferable to excessively large ones not only for seed but for general table use (aside from cooking in some few special ways), the grower should select as a standard the hills which contain a large number of medium-sized tubers, say from eight to ten, with little or no waste. A very large number is probably not advisable, for the tendency to set so many tubers would be a disadvantage should that seed be planted under unfavorable conditions of soil or climate.

As the northern potato-growing States furnish not only the seed for their own crop but that for the early crop throughout the South, the productiveness of the standard varieties of potatoes must be maintained in the North. The improvement in yield of an old variety, well tried out, is vastly more important than the originating and promoting of new varieties, and this latter task should be left to the specialist.

To the potato grower who would improve his potatoes in yield and quality a few general directions can be given, as follows:

Dig a few hundred hills by hand out of the most thrifty-appearing portion of the field and let each hill lie by itself when dug. From them select such hills as comply with the standard suggested, no matter how small a percentage of such hills is obtained. By planting these selected hills in a few separate rows and digging them the following season in the same way the first selection was made, the work of selection may be decreased. The selected hills should be planted in a seed plot each year and all the rest of the product of the plot of the previous year should be used in planting the main crop. It is inadvisable to have the seed bed on particularly rich soil, but rather under just such conditions of care and soil as the main crop. When one becomes sufficiently familiar with the appearance of separate hills and the difference in character between them, it is possible for him to select the desirable hills by following behind the digger, especially when the hills are not planted too close together in the row. With this way of making the selection, a small plot in which the selection is made by hand digging should still be kept.

CONCLUSIONS.

The recommendations to be made in methods of handling the potato crop, based on observing potato growing in various sections of the North as thus far described, are briefly as follows:

Soils adapted to potato growing.—The growing of potatoes is not by any means necessarily confined to a limited class of soils. In general, the crop is more successfully handled on soils which are naturally well drained, but sometimes equally successful results are obtained on rather heavy or moist soils which have been tile drained.

Importance of rotation of crops.—The rotation of crops in which potatoes are grown appears to be one of the most important factors for the continued success of the potato grower. The rotation should in general be the shortest which is found practicable in meeting the other demands of the farm and should be such as to give a good stand of some leguminous crop the season previous to the potato crop. Usually in northern sections the best adapted and most useful crop is clover, which should be cut for hay only one year before the land is plowed and planted to potatoes. In the North the length of time required to establish clover permits the introduction of a spring grain crop without loss of time.

Use of commercial fertilizers.—Well-chosen commercial fertilizers have been shown to be profitable when not applied to excess. The fertilizer should be selected for its formula and not on account of the statements of a manufacturer who calls it a "potato fertilizer." It is not advisable to buy a large proportion of nitrates in the form of commercial fertilizers, since a careful potato grower can furnish them more cheaply by means of plowing under the sod and stubble of leguminous crops.

Application of barnyard manure.—The man who has a supply of barnyard manure on his farm every year is the one who will find it most easy to keep up his yield of potatoes from year to year. Barnyard manure is not as a rule suitable for direct application to the potato crop, because when so applied it favors the development of scab, but in a short rotation it may be used far enough in advance of the potato crop to avoid this difficulty and in such a way as to keep up the supply of humus in the soil. Thus potato growing is possible even after the crop has been grown at intervals of three or four years for a long period of time.

Necessity for thorough cultivation of the crop.—Thorough tillage seems even more important for the potato crop than for the other ordinary field crops, since the tubers demand a soil which is not compact, in which they may grow to good size and be of regular shape. This is accomplished by deep plowing and otherwise thorough fitting of the land before planting and by continued working of the crop after planting. The crop should not, however, be cultivated deep, especially close to the rows, after the vines have attained any considerable size. In the drier soils and climatic regions the more level the cultivation the better for the crop. The potato row should never be

hilled up, if it is possible to avoid it, in a loose, well-drained soil where the rainfall is not excessive. The seed should be planted deep in the first place, so that the tubers will grow beneath the surface without hilling. In sections where the soil is more moist and the rainfall during the summer likely to be overabundant, planting more shallow and hilling up somewhat will place the seed in a warmer soil for early growth and do much toward keeping the crop suitably drained later in the season.

Spraying to prevent blight.—In the humid climate of the region near the Great Lakes and eastward to the Atlantic coast, spraying with Bordeaux mixture as a preventive of serious damage by blight is far more profitable and effective than any subterfuge, such as late planting, which may be employed.

Machinery desirable.—The thoroughgoing use of machinery in potato growing is one of the most important factors in making a crop profitable. Even when a farmer grows such a small acreage as to make it not worth while to own a planter or digger he can at least reduce the hand labor on his crop by avoiding any hoeing unless it be to cut out a few large weeds in the middle of the season. Hand hoeing can be practically eliminated on any potato field by the frequent and thorough use of a common cultivator of any kind, together with either a horse hoe for hilling the crop or a weeder for the early work in level cultivation. Both the horse hoe and ordinary weeder are inexpensive implements and the work of the latter may be accomplished with a smoothing harrow. In communities where each farmer grows only a small acreage of potatoes still further gain is made by using one planter or one digger on several farms, either as the result of joint ownership or renting of the machine.

Marketing the crop.—The successful marketing of potatoes depends very little on the immediate proximity of a center of population large enough to consume them. Unless some local freight rate is particularly exorbitant, shipment for 200 or 300 miles is no obstacle in growing potatoes. The principal requisite in shipping the crop is to have sufficient quantities to ship the potatoes in carload lots of 500 to 600 bushels. With good management a potato crop should be profitable at a selling price of 35 cents a bushel.

Maintaining a supply of humus in the soil.—Of the three sources of fertility utilized in growing a potato crop two of them together are often used with good success, but the use of all three—a rotation which provides some leguminous crop directly preceding the potatoes, live stock which furnish barnyard manure, and some form of commercial fertilizer containing potash and phosphoric acid—brings the most successful results in economical potato production, especially when continued throughout a long period of years. On this account

potato growing is often most successful on live-stock farms in the Northern States, and on such farms where most of the other crops produced are used for feeding some kind of stock the potato fits into the rotation remarkably well. On a dairy farm, for instance, where a short rotation of silage corn, small grain for hay or grain, and clover hay is grown, a potato crop is most easily fitted into the rotation, being planted on the clover sod and followed by a crop of corn for silage, the manure from the live stock being used on the corn crop and as a top-dressing on the hay crop after the grain is harvested. This is not only most advantageous for the potato crop, but this procedure gives the farmer whose income is otherwise entirely from his dairy cattle and other live stock a cash crop to sell outright and one that is safe and far more profitable than a crop of wheat, for instance, could possibly be. Potato growing in the States where it now is conspicuous seems likely to increase along with the increase of dairying or other forms of live-stock farming and not to the exclusion of those types. On the other hand, intensive live-stock farming is not likely to crowd out potato growing, but rather to increase the total production if not the acreage of the potato crop.

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